i JC17 Rec'd PCT/PTO 11 APR 2001

FORM PTO-1390 (REV. 5-93)	U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEY'S DOCKET NUMBER 10191/1790
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		U.S. APPLICATION NO. (If known, see 37 CFR 1.5) 09/807378

INTERNATIONAL APPLICATION NO. PCT/DE99/03273	INTERNATIONAL FILING DATE (12.10.99) 12 October 1999	PRIORITY DATES CLAIMED (12.10.98) 12 October 1998

TITLE OF INVENTION
RADIO METHOD AND DEVICE HAVING A FRAME STRUCTURE

APPLICANT(S) FOR DO/EO/US
RADIMIRSCH, Markus

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☒ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)) (UNSIGNED).
10. ☒ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment.
    ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
14. ☒ A substitute specification and marked-up version.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information: Copy of International Search Report, IPER, PCT/RO/101..

EXPRESS MAIL NO. EL594612538US

JC03 Rec'd PCT/PTO 11 APR 2001

U.S. APPLICATION NO. (if known, see 37 C.F.R. 1.5) 09/807378	INTERNATIONAL APPLICATION NO. PCT/DE99/03273	ATTORNEY'S DOCKET NUMBER 10191/1790

17. ☒ The following fees are submitted: — CALCULATIONS | PTO USE ONLY

Basic National Fee (37 CFR 1.492(a)(1)-(5)):
Search Report has been prepared by the EPO or JPO $860.00

International preliminary examination fee paid to USPTO (37 CFR 1.482) ... $690.00

No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) $710.00

Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO $1,000.00

International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) $100.00

				CALCULATIONS	PTO USE ONLY
ENTER APPROPRIATE BASIC FEE AMOUNT =				$860	
Surcharge of $130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).				$	
Claims	Number Filed	Number Extra	Rate		
Total Claims	16 - 20 =	0	X $18.00	$	
Independent Claims	2 - 3 =	0	X $80.00	$	
Multiple dependent claim(s) (if applicable)			+ $270.00	$	
TOTAL OF ABOVE CALCULATIONS =				$860	
Reduction by ½ for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28).				$	
SUBTOTAL =				$860	
Processing fee of $130.00 for furnishing the English translation later the ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$	
TOTAL NATIONAL FEE =				$860	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). $40.00 per property +				$	
TOTAL FEES ENCLOSED =				$860	
				Amount to be: refunded	$
				charged	$

a. ☐ A check in the amount of $__________ to cover the above fees is enclosed.

b. ☒ Please charge my Deposit Account No. 11-0600 in the amount of **$860.00** to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 11-0600. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Kenyon & Kenyon
One Broadway
New York, New York 10004
CUSTOMER NO. 26646

[signature]
SIGNATURE

Richard L. Mayer, Reg. No. 22,490
NAME

4/11/01
DATE

09/807378

JC03 Rec'd PCT/PTO 11 APR 2001

[10191/1790]

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s)	:	Markus RADIMIRSCH
Serial No.	:	To Be Assigned
Filed	:	Herewith
For	:	RADIO DEVICE HAVING A FRAME STRUCTURE
Examiner	:	To Be Assigned
Art Unit	:	To Be Assigned

Assistant Commissioner
for Patents
Washington, D.C. 20231

PRELIMINARY AMENDMENT

SIR:

Kindly amend the above-identified application before examination, as set forth below.

IN THE TITLE:

Please replace the title with the following:
--RADIO METHOD AND DEVICE HAVING A FRAME STRUCTURE--.

IN THE SPECIFICATION:

Please amend the specification, including abstract, pursuant to the attached substitute specification. Also attached is a marked up copy of the specification, indicating deleted and added sections. No new matter has been added.

IN THE CLAIMS:

Please cancel claims 1-17 in the underlying PCT application, without prejudice.

Please also cancel claims 1 and 2 in the annex to the International Preliminary Examination Report, without prejudice.

Please add the following new claims:

18. (New) A method having a frame structure for transmitting digital data in a radio communication system, the radio communication system including a plurality of central units, each of the central units assigned a plurality of subscribers, the plurality of subscribers including digital voice services, each of the digital voice services being accommodated in a data packet inside the frame structure, the method comprising:

providing multiframes, each of the multiframes being divided into a plurality of containers, each of the containers being selected to be so large that a complete transmission frame, including at least one of an uplink data packet and a downlink data packet, and corresponding signaling data, can be accommodated in a single one of the containers;

monitoring by a first one of the central units at least one complete one of the multiframes;

determining free capacity of frequency channels for further multiframes as a function of the monitoring;

occupying one of the frequency channels that has free capacity;

when there is a collision with a second one of the central units, the second one of the central units using a same time slot and a same frequency channel for a transmission frame as the first central unit, at least one of the first one of the central units and the second one of the central units: i) immediately refraining from occupying the time slot, and ii) attempting occupation again after a time lag.

19. (New) A method having a frame structure for transmitting digital data in a radio communication system, the radio communication system including a plurality of central units, each of the central units assigned a plurality of subscribers, the plurality of subscribers including digital voice services, each of the digital voice services being accommodated in a data packet inside the frame structure, the method comprising:

providing multiframes, each of the multiframes being divided into a plurality of containers, each of the containers being selected to be so large that a complete transmission frame, including at least one of an uplink data packet and a downlink data packet, and corresponding signaling data, can be accommodated in a single one of the containers;

transmitting by a first one of the central units a signal in irregular intervals, the signal announcing that the first one of the central units wants to occupy one of the containers in a following multiframe;

between transmissions by the first one of the central units, determining by the first one of the central units if another one of the central units wants to occupy a same one of the containers that the first one of the central units wants to occupy; and

if another one of the central units wants to occupy the same one of the containers, withdrawing by the first one of the central units and attempting occupation again after a lag time.

20. (New) The method as recited in claim 19, wherein the transmitting step includes transmitting the signal in random intervals.

21. (New) The method as recited in claim 18, wherein different ones of the central units can occupy a selected time slot, the method further comprising:

providing a collision prevention measure.

22. (New) The method as recited in claim 18, further comprising providing a radio cell of the radio communication system, the radio cell being assigned at least one of the containers and at least one of the frequency channels.

23. (New) The method as recited in claim 21, wherein a carrier sense multiple access/collision avoidance (CSMA/CA) method is used for the collision prevention measure.

24. (New) The method as recited in claim 18, further comprising:

selecting by the at least one of the first central unit and second central unit the lag time in a random manner.

25. (New) The method as recited in claim 18, wherein occupying step includes reserving an entire container for a multiframe.

26. (New) The method as recited in claim 18, wherein the radio communication system includes sectored radio cells.

27. (New) The method as recited in claim 18, wherein each of the central units only occupies one container per radio sector.

28. (New) The method as recited in claim 18, wherein the first central unit occupies more than one of the containers in at least one of the frequency channels.

29. (New) The method as recited in claim 18, further comprising:

occupying by the first central unit selected containers on different ones of the frequency channels using several transmission and reception branches, the selected containers coinciding or lying one behind the

30. (New) The method as recited in claim 18, further comprising:

using an ATM cell as the data packet accommodating digital voice services.

31. (New) The method as recited in claim 31, further comprising:

carrying out radio communication by using a centrally controlled protocol, the centrally controlled protocol being one of a MAC protocol, an Internet protocol, an Ethernet protocol and an UMTS protocol.

32. (New) The method as recited in claim 21, further comprising using the preventive collision measure to resolve a hidden station problem and a terminal having an occupation attempt transmitting in a transmit break of the first central unit attempting occupation, the hidden station problem including a relatively unnoticeable terminal which lies outside a radio reception range of the first central unit and the first central unit operates outside of a radio reception range of a second central unit.

33. (New) The method as recited in claim 18, further comprising selecting a large duration for the monitoring by the first central unit to provide a high probability of an active terminal transmitting once during the large duration.

REMARKS

This Preliminary Amendment cancels, without prejudice, claims 1-17 in the underlying PCT Application No. PCT/DE99/03273. This Preliminary Amendment also cancels, without prejudice, claims 1 and 2 in the annex of the International Preliminary Examination Report, and adds new claims 18-33. The new claims conform the claims to the U.S. Patent and Trademark Office rules and does not add new matter to the application.

The amendments to the specification and abstract reflected in the substitute specification are to conform the specification and abstract to U.S. Patent and Trademark Office rules, and do not introduce new matter into the application.

The underlying PCT Application No. PCT/DE99/03273 includes an International Search Report, issued April 10, 2000, a copy of which is included. The Search Report includes a list of documents that were considered by the Examiner in the underlying PCT application.

The underlying PCT Application No. PCT/DE99/03273 also includes an International Preliminary Examination Report, issued January 10, 2001. A translation of the International Preliminary Examination Report and annex thereto is included herewith.

It is respectfully submitted that the present invention is new, non-obvious, and useful. Prompt consideration and allowance of the claims are respectfully requested.

Respectfully Submitted,

KENYON & KENYON

Dated: 4/11/01

By: [signature]

Richard L. Mayer
Reg. No. 22,490

One Broadway
New York, NY 10004
(212) 425-7200
(212) 425-5288
CUSTOMER NO. 26646

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[10191/1790]

RADIO DEVICE HAVING A FRAME STRUCTURE

Field of the Invention

The present invention relates to a radio device having a frame structure, for transmitting digital data in a radio communication system.

Background Information

Conventional methods in cellular technology allow a frequency band to be used simultaneously by a plurality of radio base stations. In such a radio communication system, several terminals are controlled by a central unit, e.g., a radio base station, which, however, can also be a terminal itself. This central unit defines a radio cell, which indicates the spatial dimensions of the coverage area of the central unit. In general, such radio cells are represented as hexagons or circles in plan view. Such a system is represented in Figure 1.

Figure 2 depicts a cellular network having radio cells R1 through R8. However, if a radio cell is now defined, the terminals and the central unit generate interference which extends beyond the boundary of the radio cell. This can completely or partially prevent the operation of a second radio cell that uses the same frequency channel. As an example, the same frequency could be used in radio cells R1 and R4 in Figure 2. Because of the short distance, signals from R4 interfere with the operation of R1, and vice versa. This problem predominantly occurs when the number of allowed frequency channels is too low.

Various solutions have been proposed for this problem, which are essentially based on separating the radio channels in the frequency or code directions (FDMA and CDMA). Recently, there have also been proposals for separating the channels in the

time direction. An example of this is the DECT system.

Summary of the Invention

The present invention enables voice services to be supported by ATM, e.g., voice-over ATM. The present invention can further allow radio resources to be utilized effectively, since the outlay for overhead decreases due to the relatively large length of a transmission frame. In further refinements of the present invention, collisions can be resolved in a simple manner. The method according to the present invention is very well suited for operating sectorized radio cells.

Brief Description of the Drawings

Figure 1 shows a radio communication system in which several terminal are controlled by a central unit;

Figure 2 shows a cellular network having radio cells R1 through R8;

Figure 3 shows a schematic signaling diagram for transmitted ATM cells in an embodiment of the present invention;

Figure 4 shows the structure of a multiframe in an embodiment of the present invention;

Figure 5 shows the layout of a cellular network in an embodiment of the present invention;

Figure 6 shows an instantaneous survey of the occupancy of a container inside a transmission frame in an embodiment of the present invention;

Figure 7 shows an instantaneous survey according to Figure 6, after the addition of a further radio cell, in an embodiment of the present invention;

Figure 8 shows a collision resolution within a container, in

an embodiment of the present invention;

Figure 9 shows sectored radio cells in an embodiment of the present invention; and

Figure 10 shows the container occupancy for a particular radio cell in an embodiment of the present invention.

Detailed Description

A protocol (cf. D. Petras, A. Krämling, "MAC protocol with polling and fast collision resolution for an ATM air interface", IEEE ATM Workshop, San Francisco, CA, August 1996; D. Petras, A. Krämling, A. Hettich, "MAC protocol for Wireless ATM: contention free versus contention based transmission of reservation requests", PIMRC' 96, Taipei, Taiwan, October 1996; D. Petras, A. Hettich, A. Krämling:"Design Principles for a MAC Protocol of an ATM Air Interface", ACTS Mobile Summit 1996, Granada, Spain, November 1996) of layer 2 (DLC layer), can be used for the exemplary embodiment(s) considered here. ATM cells may be used as data packets. However, it is also possible to use data packets of other protocols above the DLC layer, e.g., IP (Internet Protocol), Ethernet, or UMTS. In this case, a layer is introduced between the DLC layer and the protocol of the higher layer, which adapts the data packets of the higher layer to the requirements of the DLC layer.

In accordance with Figure 3, which shows the basic principle of the DSA protocol (dynamic slot assignment) described in detail in German Patent Application No. P 197 26 120.5, the transmission may take place according to the TDD (time division duplex) system. The physical channel is subdivided into time slots, which each receive a data burst. Such a data burst contains an ATM cell including the overhead for a training sequence, synchronization, forward error correction, FEC, and blocking times. In the downlink signaling burst, the central controller assigns each terminal a certain transmission capacity in the form of time slots, for a

specific time interval known as SP (signaling period), as a function of the transmission resource requirements of the terminal. The total number of slots of an SP can be variable, and can vary over time. Or, the duration of the SP can be fixed, and the occupancy can be flexible.

An uplink phase includes a number of bursts transmitted by the terminals, and an uplink signaling phase. During the uplink signaling phase, the terminals are authorized to send signaling messages to the central controller, when they have not been allocated any reserved time slots for transmitting inside the normal bursts (piggy-back method). Polling or random access can be used for the uplink signaling. In the downlink phase, the signaling PDU (protocol data unit) and all of the bursts from the central controller are sent to the terminals. All of the sets of information for the next SP, including the signaling slots, are transmitted to the terminals, inside a signaling PDU. In addition, the signaling PDU contains feedback messages for previously emitted sets of uplink signaling information which, for example, can be used for a collision resolution or functions such as automatic requests for repeat (ARQ). Using these sets of information, the terminals can know when they are allowed to send and receive bursts. When different types of bursts, e.g., short or long, are used, the type of burst is announced by the central controller, inside the signaling PDU.

The reason for using such a protocol of the DLC layer is the necessity of ensuring the quality of service for ATM traffic. See also D. Petras et al.,"Support of ATM Service Classes in Wireless ATM Networks", ACTS Mobile Communications Summit, Aalborg, Denmark, October 1997. A centrally controlled MAC protocol can be used which, till now, has not been utilized in this manner in any radio communication system. On the other hand, a condition for this is that the methods already introduced for the common usage of frequencies, such as, e.g., the DECT method, cannot be used here.

One method for assigning channels in wireless ATM networks is described in A. Krämling at al.,"Dynamic Channel Allocation in Wireless ATM Networks", International Conference on Telecommunications (ICT 98), Greece, June 1998 ("ICT 98 reference"). It also lists the reasons why existing methods cannot be used. The use of the term "frame" in the ICT 98 reference is different from its use in connection with the specification of the present invention. What is referred to here as a frame (transmission frame) is referred to there as a signaling period; what is referred to as a frame in the ICT 98 reference is called multiframe below, so that a multiframe can include a plurality of containers.

The method according to the ICT 98 reference relates to frames having a flexible duration, even when the simulations are carried out using a fixed frame duration. However, the use of a fixed frame duration is especially important in connection with the present invention.

In the ICT 98 reference, a frame is divided up among several containers. This requires a very large administrative outlay for the time-related control, both in central unit ZE and in the terminals. In addition, the ICT 98 reference does not indicate any specific duration for a multiframe. The service in ATM networks is the voice service. Voice has a low processing speed, e.g., <= 64 kbit/s, but, in return, has very high demands on the end-to-end delay of the packets, as well as on the variance of this delay. If it is assumed that the end-to-end delay is limited to 50 ms, then each network element can generate a certain portion of this delay. In the case of the wireless transmission system, this amounts to 5 ms for the delay and approximately 2 ms for the delay variance. In addition, it must be taken into account that, in the case of 64 kbit/s, an ATM cell is filled approximately every 6 ms. This depends on the AAL (adaption layer) used. An ATM cell contains 48 useful bytes, from which AAL5 uses 1 byte, AAL1 uses 2 bytes, and AAL2 uses 3 bytes, so that only 47, 46 or 45

useful bytes, respectively, are available. This results in a filling time of AAL5 = 5.875 ms, AAL1 = 5.75 ms, and AAL2 = 5.625 ms. If, for voice connections, at least one container is not available for a voice connection, within the interval of the filling time, it is not possible to support voice services using ATM (voice-over ATM). Therefore, the present invention provides for using a multiframe that may have a data-packet filling time of approximately 6 ms or multiples thereof.

The present invention provides using one container per radio sector, each container transmitting a complete frame (transmission frame). Taking the 6 ms filling time into consideration for voice connections allows the radio resources to be utilized more efficiently, since the outlay for overhead decreases due to the relatively large length of a frame.

The present invention further provides for incorporating voice services into the division of a multiframe into several containers, in such a manner, that the duration of a multiframe corresponds to time period during which a data packet, e.g., an ATM cell, is filled with voice data of, e.g., a 64 kbit/s connection. As a refinement according to the present invention, the time needed to fill an ATM cell with voice information (T subscript F) approximately corresponds to the duration of a multiframe. Then, the following applies:

T sub F = T sub S

The duration of a single frame T sub R is calculated from the duration of a multiframe T sub S, divided by the number of frames per multiframe (N sub R):

T sub R = T sub S/ N sub R

Thus, the result is that the duration of a container T sub C is equal to the duration of a frame:

T sub C = T sub R

This factual situation is represented in Figure 4. In the

indicated example, multiframe S is subdivided into six containers C1 … C6. However, other numbers of containers are also possible.

The following forms the basis of a cellular network as shown in Figure 5. Three frequency channels are available, and a multiframe includes six containers. In this example, radio cells R1, R2, R4, and R5 are initially active, an instantaneous survey of the utilized frequencies and containers being shown in Figure 6. Central units ZE in radio cells R1, R2, R3, and R4 are in a steady state, so that the utilized containers do not change much from frame to frame. The required transmission capacity of central unit ZE in radio cell R4 has increased prior to the shift from multiframe S1 to multiframe S2, so that radio cell R4 occupies another container in multiframe S2, namely container C5 on frequency channel F3. In the next step, central unit ZE in radio cell R3 goes into operation. It can initially monitor the channel for a certain period of time, e.g., at least for the duration of a multiframe, and determine that the frequency channels are occupied in the manner represented in Figure 6. In this context, it is not important that central unit ZE in radio cell R3 knows the numbering of the containers, for the boundary of the multiframe must still be detected.

It can be useful in the present invention to recognize the time-related boundaries between the containers. The periodicity of the pattern can be revealed by monitoring a single multiframe, from the known duration of a multiframe, which all central units ZE working in these frequency channels must know.

From the result of monitoring multiframe S2, central unit ZE may conclude that, inter alia, containers C3, C4, and C6 of frequency channel F3 are free, and initially occupies container C4 of frequency channel F3, in multiframe S3. The resulting pattern of the used containers is shown in Figure 7.

It may be assumed that radio cell R3 would have monitored multiframe S1, and determined that container 5 of frequency channel F3 is free, and would have decided to occupy this in multiframe S2. In this case, there would have been a collision between central unit ZE in radio cell R5, and central unit ZE in radio cell R3, which, in this case, had used the same container. In order to prevent this, a method utilized, e.g., in Ethernet-based LAN's, can be put into use. This method is known as CSMA/CD (carrier sense multiple access/collision detection; see IEEE 802.3), and means that, in response to the detection of a collision, the two central units ZE immediately refrain from occupying the container, and attempt to gain access to this container, or another free container which can be on a different frequency channel, after a period of time individually ascertained by each central unit in accordance with a random process. However, this method is the collision detection by the transmitting devices, themselves. Therefore, the CSMA/CA method (carrier sense/collision avoidance) was developed for the MAC layer in wireless LAN's.

Methods, which have been developed for competition-based MAC protocols for use in wireless LAN's (local area networks), and have already been standardized, are an additional possibility for preventing collisions while containers are being occupied. These methods can be based on the so-called CSMA/CA principal (carrier sense multiple access/collision avoidance). Such methods are used in the standards of HIPERLAN type 1 and IEEE 802.11 systems, see also ETSI RES 10,"Radio Equipment and Systems (RES); High Performance Radio Local Area Network (HIPERLAN) Type 1; Functional specification", 1996; and IEEE 802.11, "Tutorial of draft standard 802.11/D3.0, Part 3: the MAC entify", http://grouper.ieee.org/groups/802/11/main.htm#tutorial. The purpose of the CSMA/CA method used in these standards is to describe a procedure, which determines how several devices wanting to communicate with each other divide the commonly used channel, and access it. In the case of the present

invention, the method provides that the devices not wanting to communicate with each other use the CSMA/CA method for occupying channels in order to not get in the way of each other. This allows devices, whose communication methods are different, and which can therefore not communicate with each other, to share a frequency band in the described manner.

In contrast to the methods described in ETSI RES 10,"Radio Equipment and Systems (RES); High Performance Radio Local Area Network (HIPERLAN) Type 1; Functional specification", 1996; and IEEE 802.11, "Tutorial of draft standard 802.11/D3.0, Part 3: the MAC entify", http://grouper.ieee.org/groups/802/11/main.htm#tutorial, it is not necessary within the framework of the method according to the present invention, that the access is granted in a priority-controlled manner. Rather, it is sufficient for each central unit ZE to select one or more randomly chosen times at which they access the new container, and otherwise, monitor to determine if another central unit ZE is accessing it as well.

Another embodiment of the present invention can involve using an entire container for collision prevention. For example, this can be useful when the duration of a container corresponds to an entire frame because, after the collision prevention phase, no more complete frames fit into the container, anyway. In this case, a central unit ZE wanting to reserve a container sends a signal at irregular and randomly selected time intervals, the signal being used to announce that the central unit wants to occupy the container in the following multiframes. Between the individual emissions, it monitors the container to determine if another central unit wants to occupy the container as well. If it determines that this is the case, then the central unit ZE that noticed the collision withdraws and proceeds as described above:

A new attempt to access this container or another free container that can be on another frequency channel, after a

period of time individually ascertained by each central unit ZE, in accordance with a random process.

An example for such a collision resolution is shown in Figure 8. Central units ZE7 and ZE8 which, for example, could come from Figure 5, attempt to occupy the same container. To that end, both of them switch between monitoring the channel and emitting a signal, by means of which the channel should be occupied. In general, it is not possible to switch over between transmitting and receiving without a time-related pause. This is represented in the drawing by a time gap between transmitting and monitoring the channel (transceiver turnaround interval, TTT). The two central units ZE initially monitor the channel. Then, they begin to transmit in a slightly time-staggered manner. However, because of the TTT, the two do not notice that a second one is also transmitting. They both transmit a second time, almost simultaneously, and in so doing, do not notice each other. During the third time, central unit ZE7 selects a shorter time interval than that of central unit ZE8, so that central unit ZE8 hears central unit ZE7 and gives up attempting to occupy the container. Since central unit ZE7 did not detect the access attempt of central unit ZE8, it continues the procedure up to the end of the container.

The method for preventing collisions can also be used to resolve the hidden station problem. In this case, a central unit ZE1 is already using the container, but is not heard by a central unit ZE2 that wants to occupy the container, because, e.g., the central unit is momentarily not in the range of reception. However, it could be, that a terminal communicating with central unit ZE1 does, in fact, hear central unit ZE2, and that the occupation of this container by central unit ZE2 can interfere with its communication with central unit ZE1. In this case, it can be useful when the terminal thwarts the access attempt of central unit ZE2, by transmitting in a transmit break of central unit ZE2 (see Figure 8), even when

this causes it to briefly interfere with the communication in the radio cell formed by central unit ZE1.

Another embodiment of the present invention for the hidden station problem involves increasing the monitoring interval (carrier sense). Since a terminal does not necessarily transmit in each frame, a central unit ZE can easily assume the container to be free after monitoring it one time. For that reason, the monitoring time must be increased prior to the occupation of a container, in such manner, that there is a high probability of an active terminal transmitting at least once within this monitoring time. Then, the central unit concerned about the container recognizes that this container is already being used, and that its own occupation would interfere with the communication in other radio cells.

The above-described method of the present invention can also be suited for use in sectored radio cells. An embodiment of such a system is represented in Figure 9. A central unit ZE is located in the middle of each radio cell, each radio cell being divided into three sectors. Residing in each of the sectors are zero terminals, one terminal, or several terminals, which want to communicate with central unit ZE. It can initially be assumed that central unit ZE controls all of the sectors, using only one frequency. The result for radio cell R3 is the occupation of containers in frequency channel F3, as shown in Figure 10. The container occupancies of radio cells R1 and R2 are not represented. Sector R3.1 occupies containers C1 and C4, sector R3.2 occupies container C2, and sector R3.3 does not occupy any container, since there is no terminal located in it.

The sectoring reduces interference between the radio cells. This is primarily based on the directionally selective effect of sectoring the radio cells. Thus, e.g., in certain usage scenarios, it is possible for container C2 of frequency channel F3 to already be used again in sector R1.3. In the

overall view of a cellular network, this considerably increases the reuseability of frequencies by reducing the interference.

Is also possible to carry out the measures of the present invention that are indicated above, when the duration of a multiframe is a multiple of filling time T_F. In this case, a central unit ZE, which must support at least one voice connection, can occupy containers having time interval T_F. It is also possible for these containers not to exactly have time interval T_F, but rather to approximately have interval T_F, the time discrepancy being limited by the allowed delay variance (cell delay variation, CDV) of the voice connection.

In the above exemplary embodiments, the container occupancy of a central unit ZE can be principally limited to one frequency, i.e., various containers of a single frequency were occupied. However, it is also possible (see the ICT 98 reference), that one ZE occupies several containers lying on different frequencies. This is also possible in the case of sectored radio cells. If there is only one transmitter/receiver unit in central unit ZE, the transceiver turnaround time should generally be considered, which can lead to a container which is not being used by central unit ZE having to lie between occupied containers on different frequencies channels. However, under the condition of one ZE having more than one transmitting and receiving branch, it is possible for one ZE to use different containers on different frequency channels, which coincide or lie one behind the other.

Abstract

A radio device having a frame structure is proposed for transmitting digital data in a radio communication system, a multiframe being used, which is made of a plurality of containers. The duration of the multiframe can be selected in such a manner that, during this time, a data packet can be filled with voice data of a predetermined bit rate. A container can be selected to be large enough, that a complete transmission frame can be accommodated therein.

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[10191/1790]

RADIO DEVICE HAVING A FRAME STRUCTURE

Field of the Invention

The present invention relates to a radio device having a frame structure, for transmitting digital data in a radio communication system.

Background Information

[The present invention relates to a radio device having a frame structure, for transmitting digital data] Conventional methods in [a radio communication system. Methods are known from] cellular technology[, which] allow a frequency band to be used simultaneously by a plurality of radio base stations. In such a radio communication system, several terminals are controlled by a central unit, e.g., a radio base station, which, however, can also be a terminal itself. This central unit defines a radio cell, which indicates the spatial dimensions of the coverage area of the central unit. In general, such radio cells are represented as hexagons or circles in plan view. Such a system is represented in Figure 1.

Figure 2 depicts a cellular network having radio cells R1 through R8. However, if a radio cell is now defined, the terminals and the central unit generate interference[,] which extends beyond the boundary of the radio cell. This can completely or partially prevent the operation of a second radio cell that uses the same frequency channel. As an example, the same frequency could [thus] be used in radio cells [C1] R1 and [C4] R4 in Figure 2. Because of the short distance, signals from [C4] R4 interfere with the operation of [C1] R1, and vice versa. This problem predominantly occurs when the number of allowed frequency channels is too low.

[Till now, various] Various solutions have been proposed for this problem, which are essentially based on separating the radio channels in the frequency or code directions (FDMA and CDMA). Recently, there have also been proposals for separating the channels in the time direction. An example of this is the DECT system.

Summary of the Invention

The [measures according to the] present invention [enable] enables voice services to be supported by ATM[(], e.g., voice-over ATM[). It allows]. The present invention can further allow radio resources to be utilized effectively, since the outlay for overhead decreases due to the relatively large length of a transmission frame. In further refinements of the present invention, [it is indicated how] collisions [are] can be resolved in a simple manner. The method according to the present invention is very well suited for operating sectorized radio cells.

Brief Description of the Drawings

[Exemplary embodiments of the present invention are explained in detail, using the additional drawings. The figures show:]

Figure 1 shows a radio communication system in which several terminal are controlled by a central unit;

[Figure 3]Figure 2 shows a cellular network having radio cells R1 through R8;

Figure 3 shows a schematic signaling diagram for transmitted ATM cells in an embodiment of the present invention;[;]

Figure 4 shows the structure of a multiframe in an embodiment of the present invention;[;]

Figure 5 shows the layout of a cellular network in an

embodiment of the present invention;[;]

Figure 6 shows an instantaneous survey of the occupancy of a container inside a transmission frame [; and] in an embodiment of the present invention;

Figure 7 shows an [instaneous] instantaneous survey [as in] according to Figure 6, after the addition of a further radio cell, in an embodiment of the present invention;[;]

[Figure 8 an example of]Figure 8 shows a collision resolution within a container [and], in an embodiment of the present invention;

[Figure 9]Figure 9 shows sectored radio cells in an embodiment of the present invention; and

Figure 10 shows the container occupancy for a particular radio cell in an embodiment [Description] of [the Exemplary Embodiments

Before the layout of the frame structure according to] the present invention [is explained in detail, a few conditions and definitions, which are used in connection with achieving the objective of the present invention, will first be explained.].

[A protocol (cf. [1], [2], [3])] Detailed Description
A protocol (cf. D. Petras, A. Krämling, "MAC protocol with polling and fast collision resolution for an ATM air interface", IEEE ATM Workshop, San Francisco, CA, August 1996; D. Petras, A. Krämling, A. Hettich, "MAC protocol for Wireless

ATM: contention free versus contention based transmission of reservation requests", PIMRC' 96, Taipei, Taiwan, October 1996; D. Petras, A. Hettich, A. Krämling:"Design Principles for a MAC Protocol of an ATM Air Interface", ACTS Mobile Summit 1996, Granada, Spain, November 1996) of layer 2 (DLC layer), [which is briefly explained below, is] can be used for the exemplary embodiment(s) considered here. ATM cells [are preferably] may be used as data packets. However, it is also possible to use data packets of other protocols above the DLC layer, e.g., IP (Internet Protocol), Ethernet, or UMTS. In this case, a layer is introduced between the DLC layer and the protocol of the higher layer, which adapts the data packets of the higher layer to the requirements of the DLC layer.

In accordance with Figure 3, which shows the basic principle of the DSA protocol (dynamic slot assignment) described in detail in German Patent Application No. P 197 26 120.5, the transmission [preferably takes] may take place according to the TDD (time division duplex) system. The physical channel is subdivided into time slots, which each receive a data burst. Such a data burst contains an ATM cell including the [necessary] overhead for a training sequence, synchronization, forward error correction, FEC, and blocking times. In the downlink signaling burst, the central controller assigns each terminal a certain transmission capacity in the form of time slots, for a specific time interval known as SP (signaling period), as a function of the transmission resource requirements of the terminal. The total number of slots of an SP [is varible,] can be variable, and [varies] can vary over time. [Another possibility:] Or, the duration of the SP [is] can be fixed, and the occupancy [is] can be flexible.

An uplink phase includes a number of bursts transmitted by the terminals, and an uplink signaling phase. During the uplink signaling phase, the terminals are authorized to send signaling messages to the central controller, when they have

not been allocated any reserved time slots for transmitting inside the normal bursts (piggy-back method). Polling or random access can be used for the uplink signaling. In the downlink phase, the signaling PDU (protocol data unit) and all of the bursts from the central controller are sent to the terminals. All of the [necessary] sets of information for the next SP, including the signaling slots, are transmitted to the terminals, inside a signaling PDU. In addition, the signaling PDU contains feedback messages for previously emitted sets of uplink signaling information which, for example, [are necessary] can be used for a collision resolution or functions such as automatic requests for repeat (ARQ). Using these sets of information, the terminals can know when they are allowed to send and receive bursts. When different types of bursts, e.g., short or long, are used, the type of burst is announced by the central controller, inside the signaling PDU.

The reason for using such a protocol of the DLC layer is the necessity of ensuring the quality of service for ATM traffic[, see also [4]. Therefore, a]. See also D. Petras et al.,"Support of ATM Service Classes in Wireless ATM Networks", ACTS Mobile Communications Summit, Aalborg, Denmark, October 1997. A centrally controlled MAC protocol [is] can be used which, till now, has not been utilized in this manner in any radio communication system. On the other hand, a condition for this is that the methods already introduced for the common usage of frequencies, such as, e.g., the DECT method, cannot be used here.

[A possible] One method for assigning channels in wireless ATM networks is described in [[5]] A. Krämling at al.,"Dynamic Channel Allocation in Wireless ATM Networks", International Conference on Telecommunications (ICT 98), Greece, June 1998 ("ICT 98 reference"). It also lists the reasons why existing methods cannot be used. The use of the term "frame" in [[5]] the ICT 98 reference is different from its use in connection

with the specification of the present invention. What is referred to here as a frame (transmission frame) is referred to there as a signaling period; what is referred to as a frame in [[5]] the ICT 98 reference is called multiframe below, so that a multiframe can include a plurality of containers.

[
Inter alia, the use of the described method for effectively implementing such a system for sectored radio cells will be discussed later.]

The method according to [[5]] the ICT 98 reference relates to frames having a flexible duration, even when the simulations are carried out using a fixed frame duration. However, the use of a fixed frame duration is especially important in connection with the present invention.

In [[5]] the ICT 98 reference, a frame is divided up among several containers. This requires a very large administrative outlay for the time-related control, both in central unit ZE and in the terminals. In addition, [[5]] the ICT 98 reference does not indicate any specific duration for a multiframe. The [critical] service in ATM networks is the voice service. Voice [does have quite] has a low processing speed, e.g., <= 64 kbit/s, but, in return, has very high demands on the end-to-end delay of the packets, as well as on the variance of this delay. If it is assumed that the end-to-end delay is limited to 50 ms, then each network element can generate a certain portion of this delay. In the case of the wireless transmission system, this amounts to 5 ms for the delay and approximately 2 ms for the delay variance. In addition, it must be taken into account that, in the case of 64 kbit/s, an ATM cell is filled approximately every 6 ms. This depends on the AAL (adaption layer) used. An ATM cell contains 48 useful bytes, from which AAL5 uses 1 byte, AAL1 uses 2 bytes, and AAL2 uses 3 bytes, so that only 47, 46 or 45 useful bytes, respectively, are available. This results in a filling time of AAL5 = 5.875 ms, AAL1 = 5.75 ms, and AAL2 = 5.625 ms. If, for

voice connections, at least one container is not available for a voice connection, within the interval of the filling time, it is not possible to support voice services using ATM (voice-over ATM). Therefore, the present invention provides for using a multiframe that [preferably has] may have a data-packet filling time of approximately 6 ms or multiples thereof.

[A development of the] The present invention [proposes] provides using one container per radio sector, each container transmitting a complete frame (transmission frame). Taking the 6 ms filling time into consideration for voice connections allows the radio resources to be utilized more efficiently, since the outlay for overhead decreases due to the relatively large length of a frame.

The present invention further provides for incorporating voice services into the division of a multiframe into several containers, in such a manner, that the duration of a multiframe corresponds to time period during which a data packet, e.g., an ATM cell, is filled with voice data of, e.g., a 64 kbit/s connection. As a refinement according to the present invention, the time needed to fill an ATM cell with voice information (T subscript F) [should] approximately [correspond] corresponds to the duration of a multiframe. Then, the following applies:

T sub F = T sub S

The duration of a single frame T sub R is calculated from the duration of a multiframe T sub S, divided by the number of frames per multiframe (N sub R):

T sub R = T sub S/ N sub R

Thus, the result is that the duration of a container T sub C is equal to the duration of a frame:

T sub C = T sub R

This factual situation is represented in Figure 4. In the indicated example, multiframe S is subdivided into six containers C1 … C6. However, other numbers of containers are also possible.

[This factual situation is represented in Figure 4. In the indicated example, multiframe S is subdivided into six containers C1 … C6. However, other numbers of containers are also conceivable.] The following forms the basis of a cellular network as shown in Figure 5. Three frequency channels are available, and a multiframe includes six containers. In this example, radio cells R1, R2, R4, and R5 are initially active, an instantaneous survey of the utilized frequencies and containers being shown in Figure 6. Central units ZE in radio cells R1, R2, R3, and R4 are [essentially] in a steady state, so that the utilized containers do not change much from frame to frame. The required transmission capacity of central unit ZE in radio cell R4 has increased prior to the shift from multiframe S1 to multiframe S2, so that radio cell R4 occupies another container in multiframe S2, namely container C5 on frequency channel F3. In the next step, central unit ZE in radio cell R3 goes into operation. It can initially [monitors] monitor the channel for a certain period of time, [specifically] e.g., at least for the duration of a multiframe, and [determines] determine that the frequency channels are occupied in the manner represented in Figure 6. In this context, it is not important that central unit ZE in radio cell R3 knows the numbering of the containers, for the boundary of the multiframe must still be detected.

It [is only important] can be useful in the present invention to recognize the time-related boundaries between the containers. [In addition, the] The periodicity of the pattern [is] can be revealed by monitoring a single multiframe, from the known duration of a multiframe, which all central units ZE working in these frequency channels must know.

From the result of monitoring multiframe S2, central unit ZE [concludes] may conclude that, inter alia, containers C3, C4, and C6 of frequency channel F3 are free, and initially occupies container C4 of frequency channel F3, in multiframe S3. The resulting pattern of the used containers is shown in Figure 7.

It [is] may be assumed that radio cell R3 would have monitored multiframe S1, and determined that container 5 of frequency channel F3 is free, and would have decided to occupy this in multiframe S2. In this case, there would have been a collision between central unit ZE in radio cell R5, and central unit ZE in radio cell R3, which, in this case, had used the same container. In order to prevent this, a method utilized, e.g., in Ethernet-based LAN's, can be put into use. This method is known as CSMA/CD (carrier sense multiple access/collision detection; see IEEE 802.3), and means that, in response to the detection of a collision, the two central units ZE immediately refrain from occupying the container, and attempt to gain access to this container, or another free container which can be on a different frequency channel, after a period of time individually ascertained by each central unit in accordance with a random process. [The problem with] However, this method is the collision detection by the transmitting devices, themselves. Therefore, the CSMA/CA method (carrier sense/collision avoidance) [explained below] was developed for the MAC layer in wireless LAN's.

Methods, which have been developed for competition-based MAC protocols for use in wireless LAN's (local area networks), and have already been standardized, are an additional possibility for preventing collisions while containers are being occupied. These methods [are] can be based on the so-called CSMA/CA principal (carrier sense multiple access/collision avoidance). Such methods are [already] used in the standards of HIPERLAN type 1 and IEEE 802.11 systems, see also [[6] and [7]] ETSI

RES 10,"Radio Equipment and Systems (RES); High Performance Radio Local Area Network (HIPERLAN) Type 1; Functional specification", 1996; and IEEE 802.11, "Tutorial of draft standard 802.11/D3.0, Part 3: the MAC entify", http://grouper.ieee.org/groups/802/11/main.htm#tutorial. The purpose of the CSMA/CA method used in these standards is to describe a procedure, which determines how several devices wanting to communicate with each other divide the commonly used channel, and access it. In the case of the present invention, the [idea is to have] method provides that the devices not wanting to communicate with each other use the CSMA/CA method for occupying channels[, with the object of not getting] in order to not get in the way of each other. [In particular, this] This allows devices, whose communication methods are different, and which can therefore not communicate with each other, to share a frequency band in the described manner.

In contrast to the methods described in [[6] and [7]] ETSI RES 10,"Radio Equipment and Systems (RES); High Performance Radio Local Area Network (HIPERLAN) Type 1; Functional specification", 1996; and IEEE 802.11, "Tutorial of draft standard 802.11/D3.0, Part 3: the MAC entify", http://grouper.ieee.org/groups/802/11/main.htm#tutorial, it is not necessary within the framework of the method according to the present invention, that the access is granted in a priority-controlled manner. Rather, it is sufficient for each central unit ZE to select one or more randomly chosen times at which they access the new container, and otherwise, monitor to determine if another central unit ZE is accessing it as well.

Another [possibility is to use] embodiment of the present invention can involve using an entire container for collision prevention. For example, this [is] can be useful when the duration of a container corresponds to an entire frame

because, after the collision prevention phase, no more complete frames fit into the container, anyway. In this case, a central unit ZE wanting to reserve a container sends a signal at irregular and randomly selected time intervals, the signal being used to announce that the central unit wants to occupy the container in the following multiframes. Between the individual emissions, it monitors the container to determine if another central unit wants to occupy the container as well. If it determines that this is the case, then the central unit ZE that noticed the collision withdraws and proceeds as described above:

A new attempt to access this container or another free container that can be on another frequency channel, after a period of time individually ascertained by each central unit ZE, in accordance with a random process.

An example for such a collision resolution is shown in Figure 8. Central units ZE7 and ZE8 which, for example, could come from Figure 5, attempt to occupy the same container. To that end, both of them switch between monitoring the channel and emitting a signal, by means of which the channel should be occupied. In general, it is not possible to switch over between transmitting and receiving without a time-related pause. This is represented in the drawing by a time gap between transmitting and monitoring the channel (transceiver turnaround interval, TTT). The two central units ZE initially monitor the channel. Then, they begin to transmit in a slightly time-staggered manner. However, because of the TTT, the two do not notice that a second one is also transmitting. They both transmit a second time, almost simultaneously, and in so doing, do not notice each other. During the third time, central unit ZE7 selects a shorter time interval than that of central unit ZE8, so that central unit ZE8 hears central unit ZE7 and gives up attempting to occupy the container. Since central unit ZE7 did not detect the access attempt of central

unit ZE8, it continues the procedure up to the end of the container.

The method for preventing collisions can also be used to resolve the hidden station problem. In this case, a central unit ZE1 is already using the container, but is not heard by a central unit ZE2 that wants to occupy the container, because, e.g., the central unit is momentarily not in the range of reception. However, it could be, that a terminal communicating with central unit ZE1 does, in fact, hear central unit ZE2, and that the occupation of this container by central unit ZE2 can interfere with its communication with central unit ZE1. In this case, it can be useful when the terminal thwarts the access attempt of central unit ZE2, by transmitting in a transmit break of central unit ZE2 (see Figure 8), even when this causes it to briefly interfere with the communication in the radio cell formed by central unit ZE1.

Another [solution] embodiment of the present invention for the hidden station problem [is to increase] involves increasing the monitoring interval (carrier sense). Since a terminal does not necessarily transmit in each frame, a central unit ZE can easily assume the container to be free after monitoring it one time. For that reason, the monitoring time must be increased prior to the occupation of a container, in such manner, that there is a high probability of an active terminal transmitting at least once within this monitoring time. Then, the central unit concerned about the container recognizes that this container is already being used, and that its own occupation would interfere with the communication in other radio cells.

The above-described method [is also]of the present invention can also be suited for use in sectored radio cells. [Such] An embodiment of such a system is represented in Figure 9. A central unit ZE is located in the middle of each radio cell, each radio cell being divided into three sectors. Residing in

each of the sectors are zero terminals, one terminal, or several terminals, which want to communicate with central unit ZE. It [should] can initially be assumed that central unit ZE controls all of the sectors, using only one frequency. The result for radio cell R3 is the occupation of containers in frequency channel F3, as shown in Figure 10. The container occupancies of radio cells R1 and R2 are not represented. Sector R3.1 occupies containers C1 and C4, sector R3.2 occupies container C2, and sector R3.3 does not occupy any container, since there is no terminal located in it.

The sectoring reduces interference between the radio cells. This is primarily based on the directionally selective effect of sectoring the radio cells. Thus, e.g., in certain usage scenarios, it is possible for container C2 of frequency channel F3 to already be used again in sector R1.3. In the overall view of a cellular network, this considerably increases the reuseability of frequencies by reducing the interference.

Is also possible to carry out the measures of the present invention that are indicated above, when the duration of a multiframe is a multiple of filling time T_F. In this case, a central unit ZE, which must support at least one voice connection, can occupy containers having time interval T_F. It is also possible for these containers not to exactly have time interval T_F, but rather to approximately have interval T_F, the time discrepancy being limited by the allowed delay variance (cell delay variation, CDV) of the voice connection.

In the above exemplary embodiments, the container occupancy of a central unit ZE [was] can be principally limited to one frequency, i.e., various containers of a single frequency were occupied. [This is often favorable from the viewpoint of implementation.] However, it is also possible [(and already described in [5])](see the ICT 98 reference), that one ZE

occupies several containers lying on different frequencies. This is also possible in the case of sectored radio cells. If there is only one transmitter/receiver unit in central unit ZE, the transceiver turnaround time [must] should generally be considered, which can lead to a container[,] which is not being used by central unit ZE[,] having to lie between occupied containers on different frequencies channels. However, under the condition of one ZE having more than one transmitting and receiving branch, it is possible for one ZE to use different containers on different frequency channels, which coincide or lie one behind the other.

Abstract

A radio device having a frame structure is proposed for transmitting digital data in a radio communication system, a multiframe [(S)] being used, which is made of a plurality of containers[(C1, C2, C3, C4, C5, C6)]. The duration of the multiframe [(S) is] can be selected in such a manner that, during this time, a data packet can be filled with voice data of a predetermined bit rate. A container [is] can be selected to be large enough, that a complete transmission frame can be [accomodated] accommodated therein.[

(Figure 4)]

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RADIO DEVICE HAVING A FRAME STRUCTURE

Background Information

The present invention relates to a radio device having a frame structure, for transmitting digital data in a radio communication system. Methods are known from cellular technology, which allow a frequency band to be used simultaneously by a plurality of radio base stations. In such a radio communication system, several terminals are controlled by a central unit, e.g. a radio base station, which, however, can also be a terminal itself. This central unit defines a radio cell, which indicates the spatial dimensions of the coverage area of the central unit. In general, such radio cells are represented as hexagons or circles in plan view. Such a system is represented in Figure 1. Figure 2 depicts a cellular network having radio cells R1 through R8. However, if a radio cell is now defined, the terminals and the central unit generate interference, which extends beyond the boundary of the radio cell. This can completely or partially prevent the operation of a second radio cell that uses the same frequency channel. As an example, the same frequency could thus be used in radio cells C1 and C4 in Figure 2. Because of the short distance, signals from C4 interfere with the operation of C1, and vice versa. This problem predominantly occurs when the number of allowed frequency channels is too low.

Till now, various solutions have been proposed for this problem, which are essentially based on separating the radio channels in the frequency or code directions (FDMA and CDMA). Recently, there have also been proposals for separating the channels in the time direction. An example of this is the DECT system.

Summary of the Invention

The measures according to the present invention enable voice services to be supported by ATM (voice-over ATM). It allows radio resources to be utilized effectively, since the outlay for overhead decreases due to the relatively large length of a transmission frame. In further refinements of the present invention, it is indicated how collisions are resolved in a simple manner. The method according to the present invention is very well suited for operating sectorized radio cells.

Brief Description of the Drawings

Exemplary embodiments of the present invention are explained in detail, using the additional drawings. The figures show:

Figure 3	a schematic signaling diagram for transmitted ATM cells;
Figure 4	the structure of a multiframe;
Figure 5	the layout of a cellular network;
Figure 6	an instantaneous survey of the occupancy of a container inside a transmission frame; and
Figure 7	an instaneous survey as in Figure 6, after the addition of a further radio cell;
Figure 8	an example of collision resolution within a container and
Figure 9	sectored radio cells; and
Figure 10	the container occupancy for a particular radio cell.

Description of the Exemplary Embodiments

Before the layout of the frame structure according to the present invention is explained in detail, a few conditions and definitions, which are used in connection with achieving the objective of the present invention, will first be explained.

A protocol (cf. [1], [2], [3]) of layer 2 (DLC layer), which is briefly explained below, is used for the exemplary embodiment considered here. ATM cells are preferably used as data packets. However, it is also possible to use data packets of other protocols above the DLC layer, e.g. IP (Internet Protocol), Ethernet, or UMTS. In this case, a layer is introduced between the DLC layer and the protocol of the higher layer, which adapts the data packets of the higher layer to the requirements of the DLC layer.

In accordance with Figure 3, which shows the basic principle of the DSA protocol (dynamic slot assignment) described in detail in German Patent Application No. P 197 26 120.5, the transmission preferably takes place according to the TDD (time division duplex) system. The physical channel is subdivided into time slots, which each receive a data burst. Such a data burst contains an ATM cell including the necessary overhead for a training sequence, synchronization, forward error correction, FEC, and blocking times. In the downlink signaling burst, the central controller assigns each terminal a certain transmission capacity in the form of time slots, for a specific time interval known as SP (signaling period), as a function of the transmission resource requirements of the terminal. The total number of slots of an SP is varible, and varies over time. Another possibility: the duration of the SP is fixed, and the occupancy is flexible.

An uplink phase includes a number of bursts transmitted by the terminals, and an uplink signaling phase. During the uplink signaling phase, the terminals are authorized to send

signaling messages to the central controller, when they have not been allocated any reserved time slots for transmitting inside the normal bursts (piggy-back method). Polling or random access can be used for the uplink signaling. In the downlink phase, the signaling PDU (protocol data unit) and all of the bursts from the central controller are sent to the terminals. All of the necessary sets of information for the next SP, including the signaling slots, are transmitted to the terminals, inside a signaling PDU. In addition, the signaling PDU contains feedback messages for previously emitted sets of uplink signaling information which, for example, are necessary for a collision resolution or functions such as automatic requests for repeat (ARQ). Using these sets of information, the terminals know when they are allowed to send and receive bursts. When different types of bursts, e.g. short or long, are used, the type of burst is announced by the central controller, inside the signaling PDU.

The reason for using such a protocol of the DLC layer is the necessity of ensuring the quality of service for ATM traffic, see also [4]. Therefore, a centrally controlled MAC protocol is used which, till now, has not been utilized in this manner in any radio communication system. On the other hand, a condition for this is that the methods already introduced for the common usage of frequencies, such as, e.g the DECT method, cannot be used here.

A possible method for assigning channels in wireless ATM networks is described in [5]. It also lists the reasons why existing methods cannot be used. The use of the term "frame" in [5] is different from its use in connection with the specification of the present invention. What is referred to here as a frame (transmission frame) is referred to there as a signaling period; what is referred to as a frame in [5] is called multiframe below, so that a multiframe can include a plurality of containers.

Inter alia, the use of the described method for effectively implementing such a system for sectored radio cells will be discussed later.

The method according to [5] relates to frames having a flexible duration, even when the simulations are carried out using a fixed frame duration. However, the use of a fixed frame duration is especially important in connection with the present invention.

In [5], a frame is divided up among several containers. This requires a very large administrative outlay for the time-related control, both in central unit ZE and in the terminals. In addition, [5] does not indicate any specific duration for a multiframe. The critical service in ATM networks is the voice service. Voice does have quite a low processing speed, e.g. <= 64 kbit/s but, in return, has very high demands on the end-to-end delay of the packets, as well as on the variance of this delay. If it is assumed that the end-to-end delay is limited to 50 ms, then each network element can generate a certain portion of this delay. In the case of the wireless transmission system, this amounts to 5 ms for the delay and approximately 2 ms for the delay variance. In addition, it must be taken into account that, in the case of 64 kbit/s, an ATM cell is filled approximately every 6 ms. This depends on the AAL (adaption layer) used. An ATM cell contains 48 useful bytes, from which AAL5 uses 1 byte, AAL1 uses 2 bytes, and AAL2 uses 3 bytes, so that only 47, 46 or 45 useful bytes, respectively, are available. This results in a filling time of AAL5 = 5.875 ms, AAL1 = 5.75 ms, and AAL2 = 5.625 ms. If, for voice connections, at least one container is not available for a voice connection, within the interval of the filling time, it is not possible to support voice services using ATM (voice-over ATM). Therefore, the present invention provides for using a multiframe that preferably has a data-packet filling time of approximately 6 ms or multiples thereof.

A development of the present invention proposes using one container per radio sector, each container transmitting a complete frame (transmission frame). Taking the 6 ms filling time into consideration for voice connections allows the radio resources to be utilized more efficiently, since the outlay for overhead decreases due to the relatively large length of a frame.

The present invention provides for incorporating voice services into the division of a multiframe into several containers, in such a manner, that the duration of a multiframe corresponds to time period during which a data packet, e.g. an ATM cell, is filled with voice data of, e.g. a 64 kbit/s connection. As a refinement according to the present invention, the time needed to fill an ATM cell with voice information (T subscript F) should approximately correspond to the duration of a multiframe. Then, the following applies:

$$T_F = T_S$$

The duration of a single frame T sub R is calculated from the duration of a multiframe T sub S, divided by the number of frames per multiframe (N sub R):

$$T_R = T_S / N_R$$

Thus, the result is that the duration of a container T sub C is equal to the duration of a frame:

$$T_C = T_R$$

This factual situation is represented in Figure 4. In the indicated example, multiframe S is subdivided into six containers C1 … C6. However, other numbers of containers are also conceivable. The following forms the basis of a cellular network as shown in Figure 5. Three frequency channels are available, and a multiframe includes six containers. In this example, radio cells R1, R2, R4, and R5 are initially active, an instantaneous survey of the utilized frequencies and containers being shown in Figure 6. Central units ZE in radio

cells R1, R2, R3, and R4 are essentially in a steady state, so that the utilized containers do not change much from frame to frame. The required transmission capacity of central unit ZE in radio cell R4 has increased prior to the shift from multiframe S1 to multiframe S2, so that radio cell R4 occupies another container in multiframe S2, namely container C5 on frequency channel F3. In the next step, central unit ZE in radio cell R3 goes into operation. It initially monitors the channel for a certain period of time, specifically, at least for the duration of a multiframe, and determines that the frequency channels are occupied in the manner represented in Figure 6. In this context, it is not important that central unit ZE in radio cell R3 knows the numbering of the containers, for the boundary of the multiframe must still be detected.

It is only important to recognize the time-related boundaries between the containers. In addition, the periodicity of the pattern is revealed by monitoring a single multiframe, from the known duration of a multiframe, which all central units ZE working in these frequency channels must know.

From the result of monitoring multiframe S2, central unit ZE concludes that, inter alia, containers C3, C4, and C6 of frequency channel F3 are free, and initially occupies container C4 of frequency channel F3, in multiframe S3. The resulting pattern of the used containers is shown in Figure 7.

It is assumed that radio cell R3 would have monitored multiframe S1, and determined that container 5 of frequency channel F3 is free, and would have decided to occupy this in multiframe S2. In this case, there would have been a collision between central unit ZE in radio cell R5, and central unit ZE in radio cell R3, which, in this case, had used the same container. In order to prevent this, a method utilized, e.g. in Ethernet-based LAN's, can be put into use. This method is known as CSMA/CD (carrier sense multiple access/collision

detection; see IEEE 802.3), and means that, in response to the detection of a collision, the two central units ZE immediately refrain from occupying the container, and attempt to gain access to this container, or another free container which can be on a different frequency channel, after a period of time individually ascertained by each central unit in accordance with a random process. The problem with this method is the collision detection by the transmitting devices, themselves. Therefore, the CSMA/CA method (carrier sense/collision avoidance) explained below was developed for the MAC layer in wireless LAN's.

Methods, which have been developed for competition-based MAC protocols for use in wireless LAN's (local area networks), and have already been standardized, are an additional possibility for preventing collisions while containers are being occupied. These methods are based on the so-called CSMA/CA principal (carrier sense multiple access/collision avoidance). Such methods are already used in the standards of HIPERLAN type 1 and IEEE 802.11 systems, see also [6] and [7]. The purpose of the CSMA/CA method used in these standards is to describe a procedure, which determines how several devices wanting to communicate with each other divide the commonly used channel, and access it. In the case of the present invention, the idea is to have devices not wanting to communicate with each other use the CSMA/CA method for occupying channels, with the object of not getting in the way of each other. In particular, this allows devices, whose communication methods are different, and which can therefore not communicate with each other, to share a frequency band in the described manner.

In contrast to the methods described in [6] and [7], it is not necessary within the framework of the method according to the present invention, that the access is granted in a priority-controlled manner. Rather, it is sufficient for each central unit ZE to select one or more randomly chosen times at which they access the new container, and otherwise, monitor to

determine if another central unit ZE is accessing it as well.

Another possibility is to use an entire container for collision prevention. For example, this is useful when the duration of a container corresponds to an entire frame because, after the collision prevention phase, no more complete frames fit into the container, anyway. In this case, a central unit ZE wanting to reserve a container sends a signal at irregular and randomly selected time intervals, the signal being used to announce that the central unit wants to occupy the container in the following multiframes. Between the individual emissions, it monitors the container to determine if another central unit wants to occupy the container as well. If it determines that this is the case, then the central unit ZE that noticed the collision withdraws and proceeds as described above:

A new attempt to access this container or another free container that can be on another frequency channel, after a period of time individually ascertained by each central unit ZE, in accordance with a random process.

An example for such a collision resolution is shown in Figure 8. Central units ZE7 and ZE8 which, for example, could come from Figure 5, attempt to occupy the same container. To that end, both of them switch between monitoring the channel and emitting a signal, by means of which the channel should be occupied. In general, it is not possible to switch over between transmitting and receiving without a time-related pause. This is represented in the drawing by a time gap between transmitting and monitoring the channel (transceiver turnaround interval, TTT). The two central units ZE initially monitor the channel. Then, they begin to transmit in a slightly time-staggered manner. However, because of the TTT, the two do not notice that a second one is also transmitting. They both transmit a second time, almost simultaneously, and in so doing, do not notice each other. During the third time,

central unit ZE7 selects a shorter time interval than that of central unit ZE8, so that central unit ZE8 hears central unit ZE7 and gives up attempting to occupy the container. Since central unit ZE7 did not detect the access attempt of central unit ZE8, it continues the procedure up to the end of the container.

The method for preventing collisions can also be used to resolve the hidden station problem. In this case, a central unit ZE1 is already using the container, but is not heard by a central unit ZE2 that wants to occupy the container, because, e.g. the central unit is momentarily not in the range of reception. However, it could be, that a terminal communicating with central unit ZE1 does, in fact, hear central unit ZE2, and that the occupation of this container by central unit ZE2 can interfere with its communication with central unit ZE1. In this case, it can be useful when the terminal thwarts the access attempt of central unit ZE2, by transmitting in a transmit break of central unit ZE2 (see Figure 8), even when this causes it to briefly interfere with the communication in the radio cell formed by central unit ZE1.

Another solution for the hidden station problem is to increase the monitoring interval (carrier sense). Since a terminal does not necessarily transmit in each frame, a central unit ZE can easily assume the container to be free after monitoring it one time. For that reason, the monitoring time must be increased prior to the occupation of a container, in such manner, that there is a high probability of an active terminal transmitting at least once within this monitoring time. Then, the central unit concerned about the container recognizes that this container is already being used, and that its own occupation would interfere with the communication in other radio cells.

The above-described method is also suited for use in sectored radio cells. Such a system is represented in Figure 9. A central unit ZE is located in the middle of each radio cell,

each radio cell being divided into three sectors. Residing in each of the sectors are zero terminals, one terminal, or several terminals, which want to communicate with central unit ZE. It should initially be assumed that central unit ZE controls all of the sectors, using only one frequency. The result for radio cell R3 is the occupation of containers in frequency channel F3, as shown in Figure 10. The container occupancies of radio cells R1 and R2 are not represented. Sector R3.1 occupies containers C1 and C4, sector R3.2 occupies container C2, and sector R3.3 does not occupy any container, since there is no terminal located in it.

The sectoring reduces interference between the radio cells. This is primarily based on the directionally selective effect of sectoring the radio cells. Thus, e.g. in certain usage scenarios, it is possible for container C2 of frequency channel F3 to already be used again in sector R1.3. In the overall view of a cellular network, this considerably increases the reuseability of frequencies by reducing the interference.

Is also possible to carry out the measures of the present invention that are indicated above, when the duration of a multiframe is a multiple of filling time T_F. In this case, a central unit ZE, which must support at least one voice connection, can occupy containers having time interval T_F. It is also possible for these containers not to exactly have time interval T_F, but rather to approximately have interval T_F, the time discrepancy being limited by the allowed delay variance (cell delay variation, CDV) of the voice connection.

In the above exemplary embodiments, the container occupancy of a central unit ZE was principally limited to one frequency, i.e. various containers of a single frequency were occupied. This is often favorable from the viewpoint of implementation. However, it is also possible (and already described in [5]), that one ZE occupies several containers lying on different

frequencies. This is also possible in the case of sectored radio cells. If there is only one transmitter/receiver unit in central unit ZE, the transceiver turnaround time must generally be considered, which can lead to a container, which is not being used by central unit ZE, having to lie between occupied containers on different frequencies channels. However, under the condition of one ZE having more than one transmitting and receiving branch, it is possible for one ZE to use different containers on different frequency channels, which coincide or lie one behind the other.

Literature:

[1] D. Petras, A. Krämling, "MAC protocol with polling and fast collision resolution for an ATM air interface", IEEE ATM Workshop, San Francisco, CA, August 1996

[2] D. Petras, A. Krämling, A. Hettich, "MAC protocol for Wireless ATM: contention free versus contention based transmission of reservation requests", PIMRC' 96, Taipei, Taiwan, October 1996

[3] D. Petras, A. Hettich, A. Krämling:"Design Principles for a MAC Protocol of an ATM Air Interface", ACTS Mobile Summit 1996, Granada, Spain, November 1996

[4] D. Petras et al.,"Support of ATM Service Classes in Wireless ATM Networks", ACTS Mobile Communications Summit, Aalborg, Denmark, October 1997

[5] A. Krämling at al.,"Dynamic Channel Allocation in Wireless ATM Networks", International Conference on Telecommunications (ICT 98), Greece, June 1998

[6] ETSI RES 10,"Radio Equipment and Systems (RES); High Performance Radio Local Area Network (HIPERLAN) Type 1; Functional specification", 1996

[7] IEEE 802.11, "Tutorial of draft standard 802.11/D3.0, Part 3: the MAC entify", http://grouper.ieee.org/groups/802/11/main.htm#tutorial

What is claimed is:

1. A radio device having a frame structure, for transmitting digital data in a radio communication system that includes, in particular, a plurality of central units (ZE), each of which having a plurality of subscribers assigned to it, including digital voice services, the individual voice services being accommodated in data packets inside the frame structure;
having the following features:
   - a multiframe (S; S1, S2, S3...) is used, which includes a plurality of containers (C; C1, C2, C3,...); and
   - a container (C; C1, C2, C3...) is selected to be so large, that at least one complete transmission frame, which includes, in particular, uplink and downlink data packets as well as corresponding signaling data, can be accomodated therein.

2. The radio device as recited in Claim 1, wherein the duration of the multiframe (S; S1, S2, S3...) is selected in such a manner that, in view of the delays inside the radio communication system, a data packet can be filled with voice data of a predetermined bit rate, during this time period or a multiple thereof.

3. The radio device as recited in Claim 1 or 2, wherein different central units/radio base stations (ZE) can occupy a time slot for a multiframe or a container, and measures are provided for preventing collisions.

4. The radio device as recited in Claim 1, 2, or 3, wherein a radio cell (R1, R2, R3...) of the radio communication system is only assigned one or more containers (C), as well as only one or more frequency channels.

5. The radio device as recited in Claim 3 or 4, wherein the following measures are provided for preventing collisions:
   - a central unit (ZE), which intends to occupy a multiframe, monitors at least one complete multiframe;
   - free capacity for transmission frames is detected in the respective frequency channels;
   - a frequency channel that is still free is occupied; and
   - when there is a collision with another central unit (ZE), which also uses the same time slot for a transmission frame in one of the frequency channels, one or both central unit(s) (ZE) immediately refrain(s) from occupying this time slot, and attempt(s) to occupy it after a time lag.

6. The radio device as recited in Claim 3 or 4, wherein the following measures are provided for preventing collisions:
   - a central unit (ZE), which intends to occupy a multiframe, using an entire container, transmits a signal in irregular, especially random intervals, the signal being used to announce that the central unit wants to occupy the container in the following multiframe;
   - Between the individual emissions, it monitors the container to determine if another central unit (ZE) wants to occupy the container as well; and
   - when it determines that this is the case, the central unit (ZE) that noticed the collision withdraws, and attempts the occupation again after a time lag.

7. The radio device as recited in Claim 3 or 4, wherein a CSMA/CA method known per se is used for collision prevention.

8. The radio device as recited in one of Claims 3 through 7, wherein each central unit (ZE) selects the time for repeating an occupation attempt after a detected collision, especially in a random manner.

9. The radio device as recited in one of Claims 3 through 8, wherein, for an occupation attempt, a central unit (ZE) reserves an entire container (C) for a multiframe, instead of a time slot.

10. The radio device as recited in one of Claims 1 through 9, wherein the radio communication system includes sectored radio cells.

11. The radio device as recited in one of Claims 1 through 10,
wherein each central unit (ZE) only occupies one container (C), particularly per radio sector.

12. The radio device as recited in one of Claims 1 through 11,
wherein a central unit (ZE) occupies several containers(C) in one or various frequency channels.

13. The radio device as recited in one of Claims 1 through 12,
wherein, using several transmission and reception branches, a central unit (ZE) occupies various containers on different frequency channels, which coincide or lie one behind the other.

14. The radio device as recited in one of Claims 1 through 13,
wherein an ATM cell is used as a data packet.

15. The radio device as recited in Claim 14,
wherein a centrally controlled protocol, especially an

MAC protocol or an Internet, Ethernet, or a UMTS protocol are used for carrying out radio communication.

16. The radio device as recited in one of Claims 3 through 15,
wherein the measures for preventing collisions can be used to resolve the hidden station problems, i.e. a terminal particularly not being noticed because it lies outside the radio reception range of its central unit (ZE), or a central unit lies outside the radio reception range of another central unit (ZE); and a terminal disturbed by such an occupation attempt possibly transmits in a transmit break of the central unit (ZE) attempting occupation, in order to thwart this occupation attempt.

17. The radio device as recited in one of Claims 3 through 16,
wherein, in order to prevent collisions, the monitoring duration for the one central unit (ZE) attempting occupation is selected to be so large, that there is a high probability of an active terminal transmitting once during this time, especially when it does not transmit in every transmission frame.

Abstract

A radio device having a frame structure is proposed for transmitting digital data in a radio communication system, a multiframe (S) being used, which is made of a plurality of containers (C1, C2, C3, C4, C5, C6). The duration of the multiframe (S) is selected in such a manner that, during this time, a data packet can be filled with voice data of a predetermined bit rate. A container is selected to be large enough, that a complete transmission frame can be accomodated therein.

(Figure 4)

09/807378

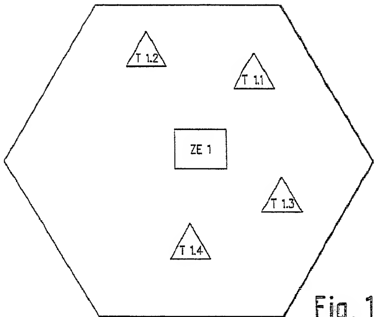


Fig. 1

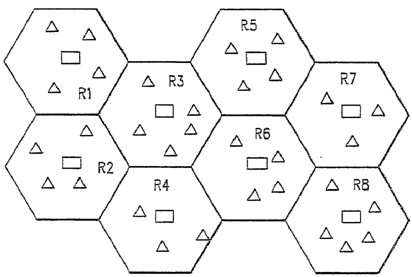
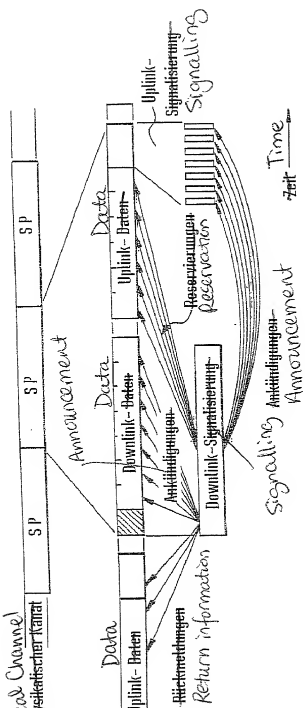


Fig. 2



Physical Channel
~~Physikalischer Kanal~~
SP
SP
SP
Data
Uplink- ~~Daten~~
Announcement
Data
Downlink- ~~Daten~~
Data
Uplink- ~~Daten~~
~~Ankündigungen~~
Downlink-~~Signalisierung~~
Signalling
~~Ankündigungen~~ Announcement
~~Reservierungen~~ Reservation
Uplink-
~~Signalisierung~~ Signalling
~~Zeit~~ Time
~~Rückmeldungen~~ Return information

Fig. 3

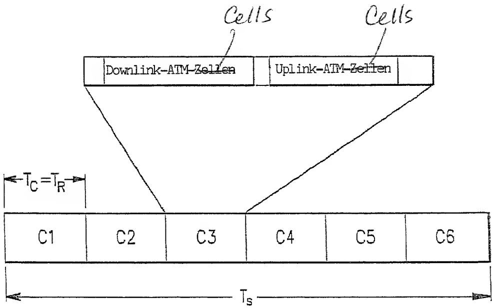

Cells
Cells
Downlink-ATM-~~Zellen~~
Uplink-ATM-~~Zellen~~
$T_C = T_R$
C1
C2
C3
C4
C5
C6
T_s

Fig. 4

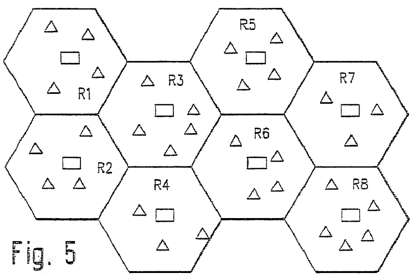

R1
R2
R3
R4
R5
R6
R7
R8

Fig. 5

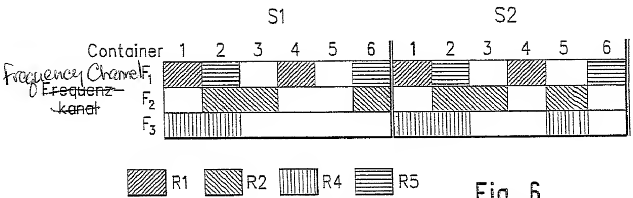

S1
S2
Container 1 2 3 4 5 6
1 2 3 4 5 6
Frequency Channel
~~Frequenz-kanal~~
F_1
F_2
F_3
R1
R2
R4
R5

Fig. 6

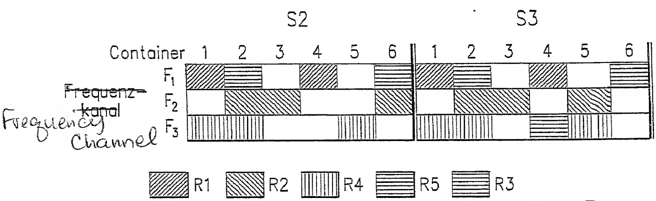

S2
S3
Container 1 2 3 4 5 6
1 2 3 4 5 6
~~Frequenz-kanal~~
Frequency Channel
F_1
F_2
F_3
R1
R2
R4
R5
R3

Fig. 7

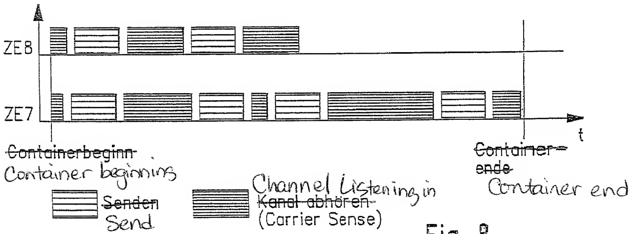

ZE8
ZE7
t
~~Containerbeginn~~
Container beginning
~~Container-ende~~
Container end
~~Senden~~
Send
Channel Listening in
~~Kanal abhören~~
(Carrier Sense)

Fig. 8

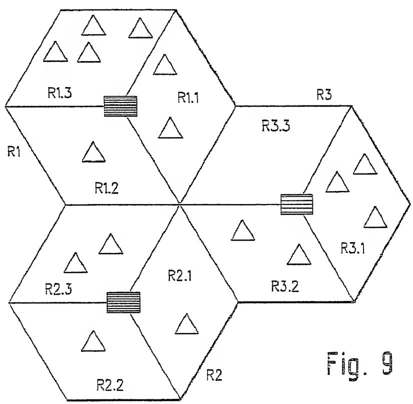

R1.3
R1.1
R1
R1.2
R3
R3.3
R3.1
R3.2
R2.3
R2.1
R2.2
R2

Fig. 9

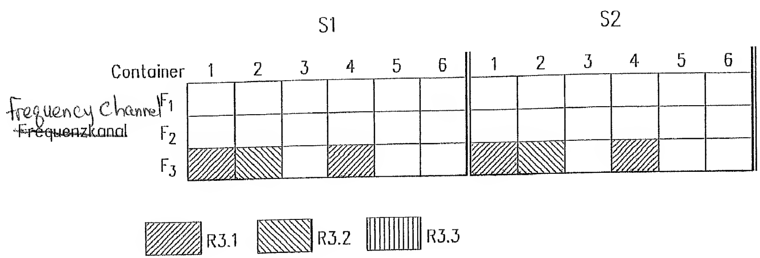

S1
S2
Container
1
2
3
4
5
6
1
2
3
4
5
6
Frequency Channel
~~Frequenzkanal~~
F_1
F_2
F_3
R3.1
R3.2
R3.3

Fig. 10

[10191/1790]

COMBINED DECLARATION AND
POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below adjacent to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled **RADIO DEVICE HAVING A FRAME STRUCTURE**, and the specification of which:

[ ] is attached hereto;

[ ] was filed as United States Application Serial No. _________ on _________, 19__ and was amended by the Preliminary Amendment filed on ____________, 19__.

[x] was filed as PCT International Application Number PCT/DE99/03273, on the 12th day of October, 1999

[x] an English translation of which is filed herewith.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a). I hereby claim foreign priority benefits under Title 35, United States Code § 119 of any foreign application(s) for patent or inventor's certificate or of any PCT international applications(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

EL244505011US

PRIOR FOREIGN/PCT APPLICATION(S)
AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. § 119

Country : Federal Republic of Germany

Application No. : 198 46 730.3

Date of Filing: 12 October 1998

Priority Claimed
Under 35 U.S.C. § 119 : [x] Yes [ ] No

I hereby claim the benefit under Title 35, United States Code § 120 of any United States Application or PCT International Application designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code § 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations § 1.56(a) which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application:

PRIOR U.S. APPLICATIONS OR
PCT INTERNATIONAL APPLICATIONS
DESIGNATING THE U.S. FOR BENEFIT UNDER 35 U.S.C. § 120

U.S. APPLICATIONS

Number :

Filing Date :

PCT APPLICATIONS
DESIGNATING THE U.S.

PCT Number :

PCT Filing Date :

I hereby appoint the following attorney(s) and/or agents to prosecute the above-identified application and transact all business in the Patent and Trademark Office connected therewith.

(List name(s) and registration number(s)):

Richard L. Mayer, Reg. No. 22,490
Gerard A. Messina, Reg. No. 35,952

All correspondence should be sent to:

Richard L. Mayer, Esq.
Kenyon & Kenyon
One Broadway
New York, New York 10004

Telephone No.: (212) 425-7200
Facsimile No.: (212) 425-5288

CUSTOMER NO. 26646

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Full name of inventor 1-00 **Markus RADIMIRSCH**

Inventor's signature Markus Radimirsch Date 25.5.2001

Citizenship Federal Republic of Germany

Residence Wirringer Garten 2
30880 Laatzen DEX
Federal Republic of Germany

Post Office Address Same as above

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